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SELECTIONS
FROM
THE RECORDS
OF
THE BENGAL GOVERNMENT.

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N^o. VIII.

R E P O R T

OF THE

EXAMINATION OF THE DISTRICTS

IN THE

JAMOODAH VALLEY AND BEERBHOOM,
PRODUCING IRON-ORE.

By

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R E P O R T
OF THE
EXAMINATION OF IRON DISTRICTS. &c.
1852.

No. 114.

FROM THE SUPERINTENDENT OF THE GEOLOGICAL SURVEY,
TO THE SECRETARY TO THE GOVERNMENT OF BENGAL,

DATED MAY 18TH 1852.

SIR,

I have the honor to forward herewith, for submission to the Most Noble the Governor of Bengal, a Report of my proceedings in connection with the Geological Survey, during the last cold weather.

My attention having been specially directed to the question of the possibility of manufacturing Iron in this country, I devoted the time to visiting those localities, where there appeared to be any geological conditions favorable to the development of this branch of industry. I did not, therefore, visit new localities so much as carefully re-examine those regarding which something was already known.

We were, further, much impeded, and indeed, entirely prevented from penetrating some parts of the country, which were covered with jungle, by not having elephants. It will be in your recollection that no elephants were available at the time of our proceeding to the field, and although they were sent after us, as soon as they could be spared, they did not reach us until the beginning of the month of March, after we had left the most difficult part of the country.

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Mr. [redacted] also, my second Assistant, could only be spared from the [redacted] department in which he had been previously engaged, about the same time: so that the Survey was in reality only working with its present force for little more than one month. My own slight acquaintance with the country was also a source of some delay, but I trust that the experience gained during the present year will enable me to take the field with greater success next season.

There are still some detailed results of our observations, determination of elevations on different localities, &c., for the complete reduction of which I have not thought it desirable to delay forwarding this Report: but which shall, as soon as completed, be forwarded.

I have, &c.

THOMAS OLDHAM.

Superintendent of Geological Survey.

REPORT OF PROCEEDINGS FOR 1851-52

My early and serious attention having been directed to the important question of the manufacture of Iron, more especially as connected with the introduction of Railways into India, by desire of the Honorable the Court of Directors, as conveyed in their Despatch, No. 27, of 1850, I took advantage, by desire of his Honor the Deputy Governor of Bengal, of the season in 1851, during which field-work in the plains of Bengal was impracticable, in directing my inquiries to this question among the Kasia Hills. The Honorable the Court had indicated as the localities represented to them as the most eligible for carrying on Iron-works, "Sikree Gully, near Rajmahal, the banks of the Damoodah River, parts of Sylhet and Beerbhoom."

Upon inquiry, it became obvious, that the "parts of Sylhet" alluded to, were the Kasia (or Cossia) Hills, where the manufacture of Iron was already carried on to some extent, and from which much Iron was brought down, and found a ready sale in the plains below. On my return from that district, towards the close of the year, I had the honor to submit to the Deputy Governor my reasons for supposing that so far at least as that portion of the country was concerned there were no

prospects of the manufacture of Iron being there carried on efficiently, or to any extent.

I was then anxious to visit and examine the coal field of the Damoodah valley, which had already been reported on in considerable detail by the late Mr. Williams, and in which extensive beds of that valuable ore, the Clay Iron-stone, were stated to occur. And with this object in view, his Honor the Deputy Governor was pleased, on the 9th December 1851(*a*), to desire me to proceed to the Damoodah valley, and from thence to pass into the country between that and the Gangetic valley; my object being to pass from the Damoodah valley through the Iron-yielding districts of Beerbhoom to Sikree Gully, at the Northern extremity of the Rajmahal hills.

Owing to the delays in preparation for the field, arising in some degree from my want of experience in the country, and from my being unacquainted with the necessary requisites for a march of some months' duration, I was not able to get away from Calcutta, until the 1st of January 1852, some weeks later than I should have desired. I then pressed forward to the coal fields of the Damoodah, and reaching Munglepore, devoted some days to the examination of the collieries of Messrs. Erskine, immediately adjoining that village; those of the Dhoba Company at Chowkeedangah; some smaller ones in the neighbourhood, now in the hands of Mr. MacSorley and some natives; and also the extensive workings of the Bengal Coal Company, at Rancegunge.

The workings at Rancegunge, at the fine colliery of Seersole (Baboo Gobin Pundit's,) and at Mr. Erskine's at Munglepore, are all carried on in the same seam of coal, a splendid bed of not less than 9 feet in thickness with a slight dip or inclination, and therefore workable at no great depth from the surface. Indeed a bed of coal so favorably placed with a view to its profitable extraction is seldom met with.(*b*)

In this portion of the coal-bearing series of rocks, however, no Iron-stones occur of any thickness or importance.

Passing westwards from Munglepore, I visited the collieries of Cheenacoory, (Bengal Coal Company), and subsequently those at Taldan-

(*a*) Mr. Under Secretary Suton-kari's letter, No. 783 dated the 9th December 1851.

(*b*) I would take this opportunity of expressing how much I was indebted to the civility and liberality of the resident Agents of all these Companies, for the free access they afforded to all parts of their workings, and the facility with which they communicated every information.

gah, Chaunch and Doomerkoondah. The latter three collieries are not at present being worked. They are on the western side of the Barakur and between the Great Trunk Road and the river Damoodah, and all belong to the Bengal Coal Company. There are also a few openings for coal, north of the Great Trunk Road, where small quantities are raised by natives; but these workings are of extremely limited extent, extremely rude in their machinery, and careless in their operations. Mr. Williams has already described in detail the associated rocks and the mode of occurrence of these beds.

Associated with these beds, and belonging to the middle section of the coal-bearing rocks, occur the beds of Clay Iron-stone, from which Mr. Williams proposed to procure the supply of ores requisite for the furnaces he purposed to establish.

These Iron-stones occur in considerable abundance, and are of an average quality, occasionally very good. They are not, however, in thick beds, few of the beds being more than 14 inches thick; and there would therefore be a very great difficulty in getting the natives to work such beds, unless by allowing them to remove such an amount of the associated rocks as would make good head-room for themselves. But this would at the same time very considerably increase the expense of working.

Having visited and carefully examined all the collieries in the Damoodah field, we proceeded westwards to Parisnath Hill, desirous of tracing the connection of the coal measures with the older rocks upon which they rest, and of becoming acquainted with the character of the latter. Doubling round the base of Parisnath Hill on the west side, we ascended to the summit from Muddubund, and were intensely delighted with the glorious scenery of the mountain itself and the striking contrast which it afforded, after having been for weeks among the almost unbroken plains of Bengal. The wonderful beauty and richness of its thickly wooded sides, broken up by the cool grey of the projecting rocks, whose precipitous cliffs cast their deep shadows around, with the almost boundless view from its summit, stretching away over the billowy ridges to the west and north-west, and the unbroken plains to the east; the clearness of the atmosphere above, while all below is shrouded in a hazy mist called up by the overheated air of the plains, all combined to render it a scene of amazing beauty, and to impress one forcibly with the idea of the desirability of such a resort being made

accessible to Europeans, as a relief from the destructive glare and broiling heats of Calcutta. (a)

From Parisnath we passed northwards through a country composed entirely of gneissose rocks, with intercalated beds of hornblende slates, and hornblende rock, with occasional granite, and thick quartzose veins, and trap dykes, to Churlimbaree coal field, described by Dr. McClelland in 1819. I was anxious here also to see the circumstances under which the Iron-stone, said to occur there, was found; its extent, quality, and the feasibility of working it. On arriving here, I found that since Dr. McClelland's report was published, Mr. Inman had opened this field, and had wrought one of the beds to some extent. The bed on which he is at present working is that at Rhamnadee, of Dr. McClelland's report, near the centre of this little field. Instead, however, of being a five-foot bed, as described by Dr. McClelland, it is in reality a bed of *eleven feet*; very rarely less than ten, but often eleven. Mr. Inman has not as yet extended his workings far: only one shallow shaft has been sunk, and all the coal has hitherto been carried out on the heads of women and coolies.

This coal is of *excellent* quality, it comes out in larger and more symmetrical masses, and is free from admixture, though still possessing the same laminar texture as the Damoodah coals. The whole of the produce is sent from the pit-mouth on carts, to Soorajgurrah, on the Ganges, and at present is entirely absorbed by supplying the Ganges Steam Navigation Company's Steamers at Monghyr. The great drawback to the full development of this little field is the immense expense necessary for the removal of the produce. The cartage alone, of the coal to Soorajgurrah (nearly 80 miles), costs upwards of five annas per maund; therefore, although at Monghyr and Patna, where coal is dear, such an arrangement may be profitable, it will be obvious that under

(a) I may state, though not immediately connected with Geological inquiries, that a good road from the plains beneath to the summit of Parisnath, could readily be made, and at a small cost. Materials are abundant and excellent, and with a little care in the selection of the line, a road of easy inclination could readily be obtained. The great objection to the hill, arising from the presence of the hordes of pilgrims who infest it, and the constant tom-tomming and noise which they make, only exists during the cold weather for a few months in the year. Before April has passed, the hill is entirely deserted by these and their priests, and remains a perfect solitude, until the return of the same season again recalls the priests by the desire of gain, and the pilgrims by their devotion to their faith.

existing circumstances, this field can only be partially worked owing to the extreme difficulty of being able to procure, in the first place, a sufficient number of carts to remove the coal, and, in the second place, a sufficient demand within such a distance as would enable it to be disposed of with a profit. A communication by Rail-road to Calcutta, and to the Ganges, would certainly increase the value of this coal field most materially.

I could not discover any Iron-stone in the Curhurbaree coal field, and I was the more surprised at this from Dr. McClelland's statement of its occurrence.

I regret further being obliged to state that many of the statements in Dr. McClelland's report are entirely inconsistent with the facts as exhibited by nature; the thickness of the beds of coal, the dip of the rocks, and the association of the beds being, in several places, very different from what they are stated to be.

I passed from Curhurbaree again to the eastward by Serampore, Junturra, and Rangoo Changoo, and thence skirted along the northern edge of the Damoodah coal field, which I had not previously examined. From thence we turned towards Soory, purposing to get along the Rajmahal Hills to Sikree Gully, if possible. The season had, however, now become too far advanced to admit of our safely entering the Rajmahal Hills. I had been instructed, by His Honor the Deputy Governor of Bengal, to be very careful; and ascertaining that after March these hills were deadly to Europeans visiting them, I, of course, avoided them. I visited a small patch of coal-bearing rocks to the north of the River More, near to the village of Tungsuli, about eight miles from Soory. (*See Map*). Here the rocks are sand-stones of various degrees of coarseness, with few associated beds of black shale, and thin irregular seams of coal. There is no bed exposed, which would at all justify the expectation that useful seams would be met with here; and the extent of the associated sand-stone is but small, not stretching for more than a mile or so, in its greatest length.

From this returning through Soory to Synthia, and thence to Dyoucha, Damrah and Bellia Narainpore, we examined carefully the Iron-yielding district of Beerbhoom, referred to in the Despatch of the Hon'ble Court of Directors, quoted above, as one of the localities, represented as likely to be favorable for the establishment of the manufacture of Iron on an extended scale.

This is a very interesting district, both from the manner in which the ore occurs, and from the simple processes adopted in its reduction. At present the manufacture is almost entirely confined to three or four villages, of which Bellia Narainpore is the largest and most important. Next to it in the extent of the workings is the village of Dyoucha, lying about 20 miles to the south of it. At Damrah also, the position of which is intermediate, there are several furnaces, at work, and also at Goanpore. But there are few villages throughout that neighbourhood, adjoining which large heaps of slags and refuse of furnace-workings may not be seen, giving evidence of the extent to which these operations had been formerly carried on, and of the long time during which they had been continued.

At Dyoucha there are at present about 30 furnaces at work for the reduction of the ore into Pig Iron, or what is called here *cutchu* iron, and about as many more for refining it, or making it *pucka* : the two operations being carried on by totally different sets of people, and, what is curious, by people of different religions; those who reduce the ore in the first instance being invariably Mussuhnen, and the refiners as invariably Hindoos.

From each of these furnaces when at work between 20 and 25 maunds of Pig Iron will be turned out during a week. The furnaces work throughout the year, with only the occasional stoppages for poojahs; that is, provided the proprietor has been able to lay in a stock of ore and of charcoal, previously to the rains commencing, sufficient to last till the weather again admits of the miners obtaining the ore. From each furnace, therefore, a produce of pig-iron of about (1,100) eleven hundred maunds, or nearly (35) thirty-five tons, is annually obtained, say 34 tons. At Dyoucha, as we have said, there are 30 of these furnaces: at Narainpore (a) about as many more; at Damrah four, and at Goanpore about 6, or in all about (70) seventy furnaces. Supposing these therefore to be all continuously at work, we should have a produce amounting to $70 \times 34 = 2,380$ tons of pig-iron in the year; a considerable amount when the rude processes of manufacture are taken into account. This Pig Iron is then sold to the refiners, and in

(a) The exact numbers cannot be stated, as they vary materially, an accident frequently throwing a furnace out of work for months; but the numbers stated above are, as nearly as careful enquiry could lead me to judge, about the average number of furnaces at work at any given time.

the process of re-melting and preparation, nearly one-fourth of its weight is lost : 10 maunds of the *cuteha* iron yielding about 7 maunds, 10 seers of the *pucca* iron. Allowing for this reduction, therefore, there would be a final produce of Iron, fit for the market, of 2,380 tons, minus 595, or 1,785 tons ; an estimate which, however, I believe to be rather too high, and that we may more fairly take the annual produce from the whole district as 1,700 tons.

Under existing arrangements, and with the present mode of conducting the operations of smelting and refining, the cost of this Iron is 1 rupee ~~4~~ 8 annas per maund, at the works, and at this rate it is barely possible for the men employed to derive a subsistence from the employment : that is, for the raw-iron a cost of £1-1s.-0d. per ton. To reduce this into a state fit for any large works, would cost at least one-half more, so that we should have the cost of this Iron brought into a convenient state for European works, about £6-6s.-0d. per ton, a price at which it is obvious that it could not compete with English Bar Iron (a) the quality of which is known. It must be remembered, however, that the quality of the Beerbhoom Iron, owing to the processes adopted and to its being smelted entirely with charcoal, is essentially different from that of English Iron, and though not so valuable for the purposes above alluded to, such as Railway works, is more so for other work, in which toughness and malleability combined with softness are required.

It remains to be considered whether any improvement in the processes of smelting could so reduce the cost as to render it available. Undoubtedly such improvements are possible, and if the Iron is to be used on any large scale, perfectly essential. But there is to my mind a very serious and insuperable objection to the adoption of such a course in the simple fact of the mode of occurrence of the ore.

This ore is an oxide of iron, partly earthy, partly magnetic, which occurs in thin seams, disseminated among and spreading in an entangled manner through the soapy *trappean* clay-stone. The bed or layer in which it occurs is on an average about five feet thick ; but the ore is by no means equally disseminated, but, like all other metallic ores, occurs in irregular bunches or nests. There is no vein ; but only thin disseminated threads or strings of ore passing in every direction across and among the clay matrix, and filling up every fissure in the mass. It is,

(a) Bar Iron (English) at present sells from £6 to £8 per ton in the Calcutta market, (May 1852.)

in fact, an infiltrated Oxide of Iron which has passed into, and been deposited in the little cracks and joints of the rock. Occurring in this way, therefore, it will be obvious that a very large proportionate amount of material has to be removed, in order to obtain any considerable quantity of the ore. In other words, the produce of any one place is soon exhausted, and the scene of operations must be changed, the ore being so scattered, and so little concentrated. With the very limited demand at present existing, this is of minor consequence, although even under present arrangements, the great heaps of refuse adjoining many of the villages, where no furnaces now exist, and where they have not existed within the memory of any of the inhabitants, indicate that this very exhausting process has taken place; that the ore in the vicinity has been worked out, and the occupation therefore abandoned. Where the profit is so small, the addition of a few miles to the distance from which either the raw ore, or the charcoal for its fusion, has to be brought, will be quite sufficient to turn the balance.

This removal is a trifling matter when the whole house and apparatus for the furnace only cost from 12 to 16 Rupees, as is the case with the native furnaces; but it would be of vital importance, and indeed fatal to the success of the effort, with large and expensive furnaces and machinery, such as would be required, were the ordinary European processes of smelting introduced. The difficulty of procuring fuel is also daily increasing. The forests and jungles are disappearing before the axe of the charcoal-burner, and the plough is steadily taking possession of lands but very recently covered with impenetrable wood. No doubt a vast extent still remains unhewn, and fuel, in the immediate neighbourhood of the woods, is still very cheap, but with a bulky article of commerce like charcoal, the expense of carriage is considerable, and the question of distance as regards the supply and the economy of it is therefore an important one.

The absence of economical fuel, therefore, combined with the scanty supply of ore, at once determines the inapplicability of any extended series of operations for smelting and manufacturing Iron in the district of Beerbhoom.

Reverting now to the valley of the Damoodah and its mineral wealth, Mr. Williams has already entered with some detail into the discussion of the question of the manufacture of Iron there. In his Report on the Geology of the Damoodah Valley, (pages 125 to 130), he has made detailed calculations of the expense of the raw materials and of the

smelting and refining of the Iron, and he gives a comparative statement of this in England and in India. His calculation is as follows: for the production of 20,000 tons of Bar Iron, No. 2, per annum, taking South Wales as the standard, he finds that there are required

	<i>s.</i>	<i>d.</i>		£	<i>s.</i>	<i>d.</i>
93,600 tons of Iron-stone @	9	3	.....	43,290	0	0
130,000 ditto Coal @	4	6	.....	29,250	0	0
18,500 ditto Lime-stone, @	3	0	.....	2,770	0	0
Or a Total cost of				£75,310	0	0

for the raw materials in South Wales. As compared with this, he estimates the Cost of Iron-stone in the Damoodah Valley at 3*s.* per ton; of coal at 2*s.* and of Lime-stone at 27*s.* Taking, therefore, as Mr. Williams does, the same quantities in both places, there would be

	<i>s.</i>	<i>d.</i>		£	<i>s.</i>	<i>d.</i>
93,600 tons of Iron-stone, @	3	0	.....	14,040	0	0
130,000 tons of Coal, @	2	0	.....	13,000	0	0
18,500 ditto of Lime-stone, @	27	0	.....	23,356	5	0
Making a Total cost of				£50,396	5	0

or a saving of £24,913-15-0 in favor of India, in the cost of the raw materials alone.

After very careful inquiry, I have been led to think that the results here given are too favorable to Indian work. In one important respect they appear erroneous. The Coal of the Damoodah Valley, even granting that it will coke well, which is not the case, is confessedly inferior to good English fuel in the ratio of not less than 20 per cent, which difference must be all added to the cost as given by Mr. Williams. As regards the Lime-stone, I believe it might be possible to have Lime-stone brought to the spot, at the rate which Mr. Williams calculated, *viz.*, 27*s.* per ton; but even this is doubtful, at least from Sylhet, from whence he proposed to procure it, when we consider that the cost of mere transport from the quarries to Calcutta, will be at least 15 Rupees per 100 maunds, or about 8*s.* and 6*d.* per ton, and that this portion of the transport is entirely by water, and consequently most economical. To this cost, the heavy land carriage from Calcutta is to be added, or if sent by water, the uncertainty and danger of the conveyance up such rivers as the Damoodah and Adji, which will materially increase the price of the stone. And again, as regards the Iron-stone, for the reasons

I have already given, I believe that for a considerable time at least after any mines were opened, if not constantly, it would be difficult to raise Iron-stone at the cost stated. From these considerations, I should be inclined to think that 4*s.* 0*d.* per ton would be a fairer cost at which to estimate the Iron ore.

Allowing for these corrections then, the cost of the raw materials for the manufacture of 20,000 tons of Bar Iron, taking the quantities as stated by Mr. Williams, would be

	s.	d.	£	s.	d.
Iron-stone, 93,600 tons, @ 4 0	4	0	18,720	0	0
Coal, ... 1,30,000 ,, @ 2 0	2	0	13,000	0	0
Lime-stone, 18,500 ,, @ 27 0	27	0	23,356	5	0
Add 20 per cent Coal to make up for inferior quality or 26,000 tons, @ 2 0	2	0	2,600	0	0
Making a Total cost of,			£57,676	5	0

Taking Mr. Williams' statement as correct, regarding the cost of the materials required for the same amount of Iron in South Wales, we would still have a saving of £17,633-15*s.* on the raw materials alone; or, in round numbers, of £0-17*s.*-6*d.* per ton of Bar Iron manufactured. A saving which, Mr. Williams himself admits, would be more than counter-balanced by the great additional cost of furnaces, blast engines, refineries, puddling furnaces, rolling mills, &c.

There remains then the saving, as compared with English Iron imported, of the freight, duty and insurance, which calculating freight at 20*s.* per ton, insurance at 2 per cent and duty at 5 per cent would give a total of £27,000 on 20,000 tons, supposing the value to be £5 per ton; or a saving of £1-7*s.*-0*d.* per ton. (a)

From this saving must be deducted the great extra charges for superintendence and management in this country; but there will still remain a considerable balance in favor of India as compared with England, of say £1, per ton.

We have here taken Mr. Williams' data as correct, and simply applied such corrections to them as appeared requisite in order to approximate the result more nearly to the facts. But these calculations having been founded on experience obtained in the working of cold-blast furnaces;

(a) Mr. Williams assumed the value at £10 per ton, but I have above taken £5 as being much more nearly the present average value of Bar Iron.

and it being certain that to contend with English Iron in the markets of this country, any manufacture of Iron must be carried on with the aid of all the improvements, which have been successively introduced in Europe, I will here give a brief calculation of the relative cost of manufacturing Iron in the two countries, under these improved modes of operation.

It is well known that the simple introduction of hot air instead of cold by the blast into the smelting furnaces, has caused a reduction in the cost of manufacture, such as was not at all anticipated. The reduction in coal alone has been in the proportion of 6·50 ; 7·0, or 7·80 to 2·00, 2·90, or 3·00 ; and besides this actual reduction in quantity the coal had originally to be coked at a cost of nearly 6s. per ton, while under the improved systems, it can be used raw, or uncoked. This difference alone therefore introduced a saving of nearly 40s. per ton of Pig Iron. The proportion of lime-stone required as a *flux* has also been reduced from 50 or 65 to 30 or 35 per ton. These differences will make an important alteration in the relative cost of the workings. Let us take, for calculation, the average of the reductions, as derived from the experience in different parts of Great Britain, and from this average calculate the relative cost in the two countries. The proportion of saving resulting from the application of the hot blast varying in each individual locality, according to the quality of the fuel, and of the ore, it will be fairer and simpler to take the *average* results, both as to quantities and as to prices. And comparing both the South Wales, and Staffordshire working with the Scotch, I think the following will be found to be a tolerably correct average result. For one ton of Pig Iron, to be reduced by the aid of the hot blast, there will be required 3 (three) tons of coal ; 2·75 tons of roasted ore, equivalent to 3·60 of raw ore ; and 75 ton of lime-stone. Of these quantities the relative cost will be

INDIA.		GREAT BRITAIN.			
	s. d.	s. d.	s. d.	s. d.	
3 tons of Coal, ... @	2 0	6 0	.....	4 6	13 6
3 60 of Raw Ore	4 0	14 4½	.....	10 0	36 0
0 75 of Lime-stone ...	27 0	20 3	.....	4 6	3 4½
		<hr/>			
		40	7½		52 10½
Add 20 per cent. of Coal					
for inferior quality,		1	2½		
		<hr/>			
		41	10½		

leaving still a balance on the cost of the raw materials of eleven shillings and one farthing (11s. 0½*d.*) for each ton of Pig Iron. I have not estimated here for the cost of labour, as this may, I think, be taken at about the same sum for both countries, and will amount to about 1 *ls.*

This saving is on the first process in the manufacture, namely, on the production of Cast Iron, in which stage of the manufacture, there is less need for trained and experienced labour than afterwards. In all the subsequent processes, in which the success of the result depends most materially on the skill of the workman, (as in puddling, &c.,) the advantage would undoubtedly be, for years to come, in favour of the manufacture in England. At the first introduction of such works, it would be essential that trained workmen and superintendents should be brought to this country, and this would entail very serious extra expense.

But taking the most favourable view of the case, and supposing that from the first establishment of such works, the other processes of the manufacture (until the Iron were brought into the state of Bar Iron, fit for the market,) could be carried on in this country for the same cost as in England, (which, it must be confessed, is making a very large concession in favour of India), it will yet remain to be considered, whether independently of all this, the actual saving in the cost of the materials, which I have shown above would be about 11*s.* per ton of Pig Iron, or in other words about one-fifth of the entire cost, or 20 per cent, would be or ought to be sufficient, under the circumstances of the case, to induce the investment of sufficient capital for the effective conduct of this manufacture.

In estimating this, it must be granted, as generally true, that although small additional profits may be sufficient to induce additional investments in a known and established manufacture, the success of which has been proved by previous experience in the same locality, it will at the same time require the prospect of very much larger returns to induce a first trial: and very justly so. The uncertainty of success, the chances of failure from some trifling difference in the conditions of two localities; the great risk attendant on the use of untrained hands, and the expenditure of time and money before the resident labourers become accustomed to, and therefore capable of executing with facility, such operations, all these greater risks demand a well-founded prospect of a very much greater return in the first instance before it can fairly be expected that capital and skill should be withdrawn from other under-

takings known to be profitable, and devoted to a speculative searching for larger returns in untried and novel schemes.

Now, as regards the manufacture of Iron, we may assume that the cost of the actual manufacture, so far as labour is concerned, will not be much less in one country than in another; and that the profits derivable from this manufacture would be about the same in both, plus or minus the difference in the actual cost of the materials, which we have already shown to be about 11s. per ton. This difference would give to the manufacturer in India, as compared with the manufacturer in England, an additional gain of about one-seventh of the entire market price of the manufactured article, or nearly 15 per cent, an additional profit, which, with the certainty of a good and steady market, ought to be sufficient to induce speculation.

The question of the market, however, or of the amount of demand for the manufactured article is an all-important one; such operations to be productive must be carried on on a large scale, and there must be a rapid sale. By a reference to Wilkinson's Commercial Annual, the total amount of Iron imported into Calcutta during the year 1851, (from 1st January 1851 to 1st January 1852), will be found as follows:

	Br. Mds.	Tons.
Total imports from Great Britain, ..	4,57,145	= 16,342
„ „ of Swedish Iron,	5,310	= 195

making the total imports equal to 16,537 tons (*a*). Of this amount only 510 tons were Pig Iron, the remaining 16,027 tons being made up of 8,259 tons of Bar Iron, 2,272 of Bolt and Rod, 1,125 of Hoop Iron, 3,913 of Sheet Iron; and small quantities of Nail Iron. In 1850, the total quantity imported was 19,099 tons, including 955 tons of Swedish Iron, and 110 tons of Pig Iron. Of Bar Iron there were 9,425 tons, of Bolt and Rod 3,383; of Hoop 2,056, and of Sheet 2,931. In 1849 the total quantity imported was 12,111 tons, including 250 tons of Pig Iron and 307 of Swedish Iron, or tabulating these numbers as below, it will appear that the amount of Bar and Bolt Iron imported, was nearly double as much in 1850 and 1851 as in 1849.

(*a*) Fractional parts of tons have been disregarded.

	Bar.	Bolt and Rod.	Hoop.	Sheet.	Nail.	Pig.	Swedish.	Other sorts old iron, &c.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1849	5139	1633	2148	2496	99	250	307	39
1850	9425	3383	2056	2931	207	110	955	32
1851	8259	2272	1125	3943	165	510	195	68

From these details it is evident that the increase in the quantity of the imported Iron, during the years 1850 and 1851, was to a considerable extent due to the increased demand created by the construction of the Railway. If, however, we take the whole amount of imports of Iron during 1851, as a fair annual quantity to supply the Calcutta market, (a) and to this amount add one-fourth as the probable increase from improvement in the arts, and in communication throughout the country, we will have a total demand in Calcutta, and the portions of the country supplied from Calcutta, of about 21,500 tons annually. Or, if we estimate the amount imported in 1849 as a fair average amount for the ordinary annual demand in Calcutta, and to this add the quantity presumed to be annually required for the extension of the system of Railways through the country, (calculated below at 13,500 tons per annum), we will have 23,560 tons as the average annual amount of the entire demand for the supply of this market during many years to come.

If further, we suppose the whole of this demand to be supplied by Iron manufactured in India, (which, however, would certainly not be the case for many years, as the character of the Iron produced in this country, should, like every new article of commerce, be established before it would be purchased with confidence,) but if we suppose that the whole of this Iron were produced in India, there would be required for

(a) As at present intended, the rails to be used on the East Indian Railway are to be 84 lb rails, equivalent to 132 tons of Iron per mile for a single track, or allowing for extra sidings, double lines at stations, &c. &c., say 150 tons per mile : and supposing that after the delays inseparable from the first commencement of such a great undertaking, 80 to 100 miles should be annually completed, this would require a supply of 12,000 to 15,000 tons annually, say an average of 13,500.

such an annual out-turn, about eleven blast furnaces capable of producing each forty-five tons per week. (*a*)

Let us roughly estimate the amount of capital, which such an establishment would demand. The average cost of such a blast furnace, as we have supposed, would in England, be from £3,200 to £3,500 sterling, and considering the very large proportion of this cost, which goes for fire-bricks (not less than £1,100) for cast and wrought Iron &c., (about as much more or £1,100), and knowing that at the first establishment of such furnaces, these materials must necessarily be imported, we are justified in stating that such a furnace could not be put up well in this country, for much less than one-half more, or for each blast furnace a cost of £5,000 sterling. For this there will be required all the blast machinery, steam-engine, engine-house, &c., which, supposing that for the sake of economy, one large engine is made to do the work of (3) three furnaces, will cost at least £6,000 more (*b*). For three furnaces therefore with blast apparatus, engine, &c., complete, the cost would be £21,000 (*viz.* 3 furnaces each £5,000, £15,000; and blast apparatus, &c., £6,000). Each blast furnace will require *one* finery furnace, and about *five* puddling furnaces, to reduce the Cast Iron produced from the blast furnaces into Bar Iron. Taking these at a cost of £500 each, we have to calculate £3,000 for this portion of the establishment. There are besides required all the machinery for working up this Iron; tilt-hammers, reheating furnaces, rolling mills, mill furnaces, &c., &c., and a steam-engine to drive them. Supposing here also that an engine is taken of sufficient power to drive all these mills, and that they are capable of roughing and rolling, say 135 tons per week, or the entire produce of the three blast furnaces, such machinery would cost at the least, £7,000 sterling. In all, therefore, for furnaces, blast-machinery, reducing mills, &c., capable of turning out 135 tons per week the total cost would be £31,000. To this we must add for spare pieces of machinery, additional rollers, &c., &c., at least £5,000 more, or about £36,000. After four or five years' work, much of these buildings and machinery will require renewal or repairs; and we cannot therefore fairly estimate the interest on this capital expended at

(*a*) I have here estimated for a small size of furnace, as unquestionably at the first introduction of such a manufacture, it would be more prudent to adopt the smaller size.

(*b*) The average yield per horse power per week in Great Britain, may be taken at 2.10 tons. This would require an engine of nearly 65 horse power for three furnaces, yielding 45 tons weekly each furnace.

less than £15 per cent. in this country ; or at £5,400 per annum, which must be paid before any profit can be derived from the workings. To meet this, the return in produce, as calculated above, would be 135 tons per week, or taking 50 weeks' work in the year, of 6,750 tons per annum ; yielding at the saving on the cost of the raw materials, which I have previously shown might be calculated on, (*viz.*, 11s. per ton,) £3,712-10s.-0d. per annum, or deducting this from £5,400, the interest on the capital sunk, &c., there remains £1,687-10s.-0d. of interest on capital to be paid out of the ordinary profits of the trade : or supposing the whole out-turn of 6,750 tons to be sold at £5 per ton ; of exactly one shilling on each ton sold. (a)

We may put the matter in another way, as illustrative of the comparative cost of similar works in other places. An establishment of the kind we have estimated for above would in England cost as follows :

3 Blast furnaces, . . @ 3,500=	£10,500	0	0
Blast apparatus, engine, &c.,	3,500	0	0
Rolling mills, engine, engine- house, additional machinery, forges, &c., &c.,	7,000	0	0
	£21,000	0	0
In India, as calculated above,	£36,000	0	0

In Great Britain the interest on such capital may fairly be taken at £12 per cent per annum ; while in India it cannot justly be estimated at less than £15 per cent. In the one case, therefore, the payment of interest on the capital expended will require only £2,520 ; in the other case, not less than £5,400, a difference of £2,880 ; while the difference in the cost of the materials, and the profit consequent on this, estimated as above, at 11s. per ton, will only amount to £3,712-10s.-0d., leaving only the small sum of £832-10s.-0d. upon an expenditure of £36,000, as the *total of the additional profits*, which might be justly anticipated in this country on such a manufacture. In other words, the relative advantages derived from the saving in the cost of the raw materials are in the ratio of 41 to 52, while the relative expenditures are in the ratio of 36 to 21. The additional cost therefore of buildings, machinery, &c., in this country, nearly counter-balances any advantage derivable from the saving on the raw materials.

(a) In order to give the fullest advantage to the Indian side of the question, we have above estimated the full out-turn of the blast furnaces, as converted into Bar Iron. The loss, however, in the processes of refining, puddling, &c., is considerable, and the 135 tons of Cast Iron would not in reality give more than 105 tons of Bar Iron.

We have here estimated only for three furnaces, and for mills, &c., to correspond, this being a convenient arrangement. But to meet the entire demand of the Calcutta market, as stated above, would require eleven furnaces of the same size, or at the same cost an expenditure of not less than £132,000. It is perfectly obvious that such an amount would never be expended at once, and the growth of an establishment or establishments of that kind could only be very gradual. (a)

Seeing then that any additional gain, which could fairly be anticipated in this country, would be nearly counter-balanced by the great extra cost of machinery, &c., it will be unnecessary to state a conviction that the ordinary profits of the Iron trade, though these are occasionally large, would never be sufficient to induce the investment of the necessary capital for such undertakings.

There is an important point to which we have not alluded above, inasmuch as we calculated on the use of the hot-blast; but which would be a very serious disadvantage in this country, as compared with colder climates, if the old system of cold-blast furnaces were continued: we allude to the well-known fact of the diminished efficiency of the furnaces in Europe during summer, as compared with winter, producing a difference in the amount of ore smelted of sometimes fully one-third of the usual out-turn.

Neither have we taken into account the saving of freight; of insurance and of duty, because we feel satisfied that any advantage accruing to the manufacturer in India, from these sources, as regards the supply of the Indian market, would be fully counter-balanced by the extra risk attendant on the manufacture here, and the extra charges for superintendence, &c.

It appears, therefore, most obviously and clearly to result from these considerations *that, under existing conditions, the manufacture of Iron, on any efficient scale, and on the European system, cannot be undertaken in this district, with a certain prospect of such a return as would justify the great outlay required.*

I say "under existing conditions," because increased facilities of communication, or other improvements, may so alter these conditions, as to render such undertakings remunerative. To give an instance of this, the cost of lime-stone, an essential ingredient, has been given above at 27s. per ton; and has been supposed to be obtained from

(a) Some of the largest Iron Works in England have not more than 10 or 12 furnaces at work.

Sylhet. A much nearer, though at present inaccessible, source of supply would be from the banks of the Soane River. Were a direct line of Rail-road communication opened out from the Damoodah Valley to the Ganges, at Patna, or to the Soane, lime-stone could be brought to the Damoodah Valley for about 10s. per ton, instead of 27s., a very important difference, while the same line of communication would open up all the markets of the North-West Provinces to the manufacturer. The essential dependence, which the progress in arts and civilization of any country has, on the abundance, cheapness and applicability of Iron, is well known ; but there are few countries, where such progress is more required than in India, where the rich and varied products of the country demand for their profitable conversion the more economical processes of improved machinery, and the more rapid and facile means of transport derived from improved communications.

As yet this glorious land, with all its wealthy towns, its noble rivers, its extensive plains, its uncounted mineral treasures, and its unrivalled natural productions, has scarcely emerged from the barbarous stage of its history, of which the precious metals are in some degree the type ; when wealth is sought for, as a means of displaying the gilded state of its owner, and enabling him to tyrannize over his fellow-men, where the gorgeousness of a semi-barbaric state is at once the offspring and the parent of a besotted ignorance, and a degraded fanaticism ; and where few traces of progress, other than those which have been forced upon the people, can be seen during centuries past. To such a country the importance of opening up a supply of good Iron at a cheap rate, and thus giving an impulse to its ten thousand applications, can scarcely be over-rated, and the advantages resulting from the development of its manufactures, can scarcely be over-estimated.

But such a development, to be successful and permanent, must be gradual ; and in accordance with the established and just principles of commerce. No eager zeal for the country's benefit must be allowed to injure the real success of the attempt by *premature*, and therefore un-availing efforts, while at the same time the true and fitting season must be carefully watched ; and the rich fruit gathered as soon as it is ripe, and fit for use.

No person can be more fully alive to the very great advantages which must accrue to this country from the development of such manufactures ; or more keenly sensible of the disadvantages under which she labours in consequence of the want of them, than I am ; but, after careful

consideration of the subject, I am satisfied, that, so far as the districts which I have had the opportunity of visiting are concerned, the attempt would at present be *premature*, and therefore comparatively unsuccessful.

Such development must follow, and be a consequence of increased facilities of intercommunication, and can never be looked to as a forerunner, or a cause of such facilities. But the one will inevitably result from the other.

Connected with this subject, and as my attention was particularly directed to it by the Hon'ble the Court of Directors, as bearing on the establishment of Railways in India, I may be excused for alluding to another question, which has been forcibly impressed upon my mind, during the examination of the country which I recently visited; namely, the direction which the line of Railway to be established ought to take, and the point at which its terminus ought to be placed.

From information conveyed through the public papers, I believe that the present arrangement is that the line as far as the neighbourhood of Pundooah or Purrooah, about 10 miles from Bandel, or else as far as Burdwan, should be considered as a trunk line; that from a point near to the latter place, two lines should diverge; one to pass almost due Northwards to or towards Rajmahal; which is to be considered a portion of the main line, and to be constructed with a view to its continuance towards the North-west; and another line, which would be considered as a branch line, and be constructed towards, but not altogether up to, the collieries of the Damoodah Valley.

I have no official or positive information on this subject; but I believe, that such is the arrangement proposed; and I am also under the impression that this arrangement has not been finally sanctioned or determined on, but that the question is still an open one. Under this impression, I venture to express an opinion that such an arrangement is calculated most materially to injure any prospects of success which the proposed line may have.

There are two distinct points which I would consider. *First*, granting that the arrangement at present contemplated be carried out, to consider the proper position of the terminus for the colliery line; and *secondly*, to consider the advantages or disadvantages of the general line selected for the main branch of the Rail-road.

I am informed that the present intention of the Company is to make the terminus of the colliery line on the lands of Buckternagur,

near to the Dāk Bungalow, and only a short distance to the South and East of Munglepore. Now I believe the only possible advantage which such a position can claim is, (the rather dubious one for a colliery branch), that it is altogether outside of the present workings for coal; and that therefore it directly affords no greater facilities or advantages to one proprietor than to another. But I would submit that the object of constructing a Rail-road to these collieries at all, is evidently to assist in developing the valuable and extensive resources of the district, and to meet the traffic arising from the constant demand for this fuel.

Now what are the circumstances of the case? A reference to the Plan, which accompanies this Report. (*No. 2*), will show the position of the several colliery-workings in the district; and from this it will be seen that the nearest of these collieries will have to transmit their coal to the Railway terminus, a distance of scarcely three-fourths of a mile, while some of the others will have a cartage of not less than (20) twenty miles. If therefore in fixing the present terminus, it were any object to avoid conferring advantage on one party more than another, this object has not been obtained; as, however indirectly, a most essential advantage is conferred on those collieries which are nearest to the proposed locality.

But there is another, and in my mind a much more important consideration, arising from the facts regarding the present facilities of transport to market of the coal, and those which would exist under a system of Railways.

At present it is well known that all the coal from this district is sent down to Calcutta in boats by the Damoodah, a river, or rather torrent, which is only navigable for a few months in the year, and even then during floods only. At these times, an immense fleet of boats may be seen starting from the several wharfs or ghats along the banks, and stretching in a continuous line for some miles in length. Should the flood continue, these boats, with few exceptions, reach Ompta (where the river becomes sufficiently deep to be navigable at all seasons) in safety, but should the water fall, as often happens before they have accomplished this distance, they are left stranded on some chur possibly to get off again during some succeeding rise of the water, but more probably to be destroyed and lost. Under these conditions, it is necessary that the several proprietors should cart to the river bank and there pile up in large heaps all the coal raised during the months elapsing between the

close of the rainy season of one year, and its commencement in the succeeding one. Much coal is in this way exposed in uncovered heaps to the weather during seven or eight months, after which it may be sent down the river, to be again retained at the *dépôt* for months before it comes to market. Indeed, but little of the coal from this field reaches the Calcutta market till after fifteen or eighteen months have passed subsequently to its being raised from the pit.

Again inasmuch as the quantity sent down, supposing a sufficient number of boats can be had, is altogether dependent on the amount and continuance of the rains, it not unfrequently happens that much of the coal, which has been raised and stacked on the river bank, waiting to be sent away, is necessarily left behind, and remains exposed to all the weather for another twelve-month. Much coal in this way comes to Calcutta market after being exposed for *two years*, quite sufficient most materially to injure the good qualities of any coal; and especially one possessing the peculiar structure of the Damoodah coal. The year 1851 was a remarkably dry one in Bengal, and when I visited these collieries, a few months since, there were many *lacs of maunds of coal* still remaining on the banks of the river, which the proprietors had expected to have been able to despatch during the last rains, but could not.

Another fact of importance is this, that the facilities for the despatch of the coal decrease very rapidly as we go up the stream; so that from the ghats near Rancegunge and Rogonathchuck collieries, it is often possible to despatch the boats when there is not sufficient water higher up the stream at Cheenacoory, or still higher at Chaunch and the adjoining collieries. Indeed the great reason, I was informed, why the collieries of Chaunch, Taldangah, and Doomerkoondah are not now worked, is, that as much coal can easily be raised at Rancegunge as can be shipped in the year, and therefore there is no use in wasting time and capital in supporting the other collieries. The same statements *mutatis mutandis* apply to the collieries which ship their produce on the Adji.

The collieries situated to the west of the river Barackur, being at present full of water and not worked, I was not able to see them myself, but Mr. Williams in his Report states that the coal at Taldangah is superior to any other coal in the field, and that it will *coke* well. Although what I could see did not support this description, it may, I think, be considered fully equal to the coal at present turned

out. Again the coal at Cheenacoory, the most westerly colliery on the Damoodah, before crossing the Barackur, is also of very good quality.

Now it appears to me obvious, if the formation of a line of Railway to this coal field be undertaken with any view to the development of its resources, through the medium of increased facility and rapidity of communication, *that such line of Railway should be carried to the furthest convenient point in the coal field*; and should be made so as to afford aid to those collieries *especially*, which from their position are at present most in need of it: while if thus carried all through the centre of the field, no greater advantages will be conferred on one colliery than on the others.

On the other hand, the adoption of the present proposed position for the terminus will inevitably tend to the development of those collieries only, which are at present most favourably placed; and to the entire abandonment of the others, which, though equally good as regards the quality and cost of the coal, will by their position be deprived of the advantages of the improved system of communication.

The importance of a line of Railway being carried to the Western extremity of this coal district, as bearing on the possibility of economizing its valuable deposits of Iron-stone has been already indicated in a preceding portion of this Report. And we may add here that could such a line of Rail-road be continued towards the North-west so as to open up the markets of that important portion of the country, the value of this coal field would be most materially enhanced.

If these views, therefore, be correct, it would not only be fair and just, but indispensable, that the rail should be continued through the coal field of the Damoodah, and not stop short of it at the present proposed terminus.

This extension would involve an addition of less than 20 miles, in a country very favorable for such works; and where a single line, amply sufficient for all the traffic, could be made for £6,000 per mile; or the 20 miles for £120,000, thus requiring a traffic producing only £6,000 per annum to pay 5 per cent on the original outlay.

The other question of the proper direction of the main line of Railway, with a view to its continuance towards the North-west Provinces, remains to be considered. And in viewing this subject, there would appear to be several facts so obvious, that there can be little hesitation in admitting them as axioms.

Of these one appears to be, that in India for many years to come, the *goods traffic* will be the principal source of revenue on any line of Railway to be constructed. From this it follows that while it is desirable that such gradients or inclines should be obtained as will enable heavy trains to be pulled with facility at a small cost of power, it is not desirable that such an end should be gained at the cost of a great expenditure, or that gradients of such a character should be sought for as would approximate the line to a perfect level, along which the maximum amount of speed could be obtained for express passenger trains. Now it is well known to every Engineer conversant with Railway works; that a gradient of 1 in 300 may for all practical purposes be considered as nearly approaching to a level; in other words, that on such an incline the effect of gravity, in retarding the ascent of a train, is such that it may be nearly disregarded. I would conclude, therefore, that it will be useless to seek for any line, on which the maximum inclination shall be less than 1 in 300. Over a great part of Bengal the gradients would of course be much less than this; but if the maximum inclination be not more than 1 in 300, and that such a gradient can be obtained without any disproportionate expenditure, it must be conceded that such a line would be a most excellent, and as far as the gradients are concerned, an economical working line.

It must also be borne in mind, that certainly the larger portion of the traffic to be conveyed over any line, stretching in the direction proposed, would be traffic tending towards Calcutta and not from it; and therefore that such inclination as the line of Railway would have, due to the gradual and continuous rise of the country towards the North-west would be in the direction favourable for the carriage of the greatest amount of traffic.

I believe it will also be granted that, for many years at least, the *roadside* traffic will be very small. From this it results that but little regard need be had to small existing towns or marts on the line, provided the general direction be favourable; it being more certain that the Railway will itself develop its own traffic, and give rise to towns, and marts in favourable places, than that it will derive much benefit from small existing ones. At the same time the large and established marts of the country must form one great source of traffic and revenue to the line.

In a national point of view, that is, on public grounds independently of the question of profit, it is desirable that as rapid a communi-

ation as possible should be established between the great seats of power in the country, and that, therefore, *the shortest possible line, consistent with other considerations, should be adopted.*

In laying out any line of Railway, with a view to obtaining a return or profit on the outlay, it is desirable, as far as possible, to avoid competing with other and cheaper modes of conveyance, and this more especially where the *goods traffic* will be the most important. It is also desirable that the line should not command only a *one-sided traffic*.

If these views be correct, and I believe they cannot be questioned, I feel satisfied that a better line for the proposed Rail-road can be obtained than that at present contemplated towards Rajmahal. And I have been led to this view, and to the present notice of the question by having passed through a district of country during our late geological examinations which does not appear to have been in any way examined heretofore with reference to the line of intended Railway communication.

On the accompanying sketch map (No. 3) are marked *in red* all the directions of the Rail-road, which I have heard spoken of. These lines naturally divide themselves into two groups; one which would take the direct line from Calcutta to Benares or Mirzapore, the other group which would follow the valley of the Ganges, and in order to do so, would wind round the foot of the Northern extremity of the Rajmahal Hills. To the first group, there exists the very strong and insuperable objection of the impossibility of obtaining sufficiently favourable gradients without a very large expenditure of both time and money; to the second group, the very strong objections, from the greatly increased length of line, from its running parallel to the greatest line of water carriage in the country (the cheapest that can be obtained), and from the difficulties of construction owing to the distance of materials and the nature of the rivers to be crossed. In favour of the direct lines there are the greatly diminished length, and some other points; in favour of the Ganges valley line, the extremely favourable gradients, and the certain amount of traffic which the Rail-road is likely to meet at Rajmahal.

Now granting at once that the nature of the country on the direct lines is such as to render the construction of a Rail-road too difficult and expensive, it yet remains to be seen whether there be not some line between this direct line and the Ganges Valley, which should be practicable and which should combine the advantages of both the others.

The great difficulties, as is well known, on the direct line were at and near to Dhunwa Pass, where the line of hills forming a portion of the great range passing North-east towards Curruckpore, skirts the plains of Behar; and on any line passing in the proposed direction, this range must be crossed. But I believe there exist natural passes through which a more favourable line could be obtained than at Dhunwa Pass, and these I believe should have been examined.

In all the propositions which have been hitherto made for a direct line, Benares or Mirzapore has been the great terminus selected, and the line has been accordingly so arranged as to meet the Ganges, at or near these places. I conceive, however, that the great traffic centering in the large and populous marts lower on the Ganges is sufficiently important to demand attention. The first of these great marts in ascending the river is undoubtedly Patna, a town of some 350,000 inhabitants, and one of the largest and most important markets in Bengal. In fact this town was considered of such importance, that under the former proposition of a direct line to Benares, it was also contemplated to make a branch to Patna, in order to command its traffic. A Rail-road carried direct to Patna, would also intercept there a large portion of the traffic of the Ganges River, in fact *all* the River traffic which the line to Rajmahal can obtain, with the exception of that portion only which enters the Ganges, from the North, between Patna and Rajmahal, and which undoubtedly does not amount to more than one-fifth of the entire traffic passing Rajmahal. And I believe, that it would command this traffic with greater certainty by offering the greater inducement for its transfer to the Rail-road, of the boats escaping the very difficult navigation of the River between Patna and Rajmahal, where the entrance of the Cosi, the rocks of Sultangunge and Colgong, and other difficulties, render it peculiarly dangerous.

As regards distance, these two lines (namely, one from Calcutta to Patna direct, as now proposed; and one from Calcutta to Rajmahal and thence to Patna), would bear the ratio of 4 to 5, or taking Patna by the direct line as 400 miles, the line by Rajmahal to reach the same point would be 500 miles; or a saving of 100 miles in 500; (a) in other words a saving of capital, amounting at least to £1,000,000 sterling,

(a) It is not intended that these numbers should be understood to express the actual distances correctly, but only approximately, and with sufficient accuracy, the relative distances. Until the lines were actually surveyed, the exact lengths could not be ascertained.

taking £10,000 as the average cost per mile, (an estimate below the present cost) and a saving of probably two years in time of construction, while a return of the very large sum of £50,000 per annum more on the one line than on the other, would be requisite to meet the payment of £5 per cent interest to the proprietors.

Another important consideration is this, that the extension of the proposed colliery branch to Patna, could be made in very nearly the same time which will be required to construct the line to the Ganges at Rajmahal, while it is certain that any goods traffic which it can be expected to meet on its continuation from Rajmahal to Patna, it will meet at the latter place.

With reference to traffic, therefore, I am satisfied, that the line now suggested, direct to Patna would, as far as the coal fields, be under exactly the same conditions as the present colliery line; and if it be desirable to make such a branch now, this branch or portion of a main line would of course be a more paying project then. With regard to the further portion; viz., between the Damoodah coal field and Patna, I may state that there is at present a very considerable traffic along the route which it would take. When passing along we met droves of pack bullocks covering the road for miles each morning and passing to and fro in a continuous stream, carrying up supplies for the extensive district of country between the Barackur River and the Ganges, and bringing down the produce of that district. And undoubtedly much of this traffic would come to the rail (a). It would have the additional advantage of going within a short distance of the Curhurbaree coal field, and the mines of Deoghur.

I can only speak from personal inspection of a part of the line now proposed, namely so far as some little distance north and west of Curhurbaree. Thus far however, the country is extremely favourable; and a nearly direct line could be had on which gradients, not exceeding 1 in 300 or 400 could readily be obtained. Northwards from this point until reaching the descent of the ghats into the plains around Patna, even more favorable gradients can be obtained; the country being remarkably level, and in fact a continuous plain, or table land. There remains, therefore, a distance of not more than a few miles, regarding which there can be any doubt, and this doubt could be settled in a

(a) Even supposing that a Rail-road should not be constructed here, a great and lasting benefit would be conferred on the district by the construction of a good road.

week (a). The ghats once passed, there can be no difficulty whatever across the level country from the neighbourhood of Guidore to Patna.

Indeed from every inquiry which I have been able to make, I believe that a good practicable line could be obtained throughout at a small expense.

The question appears to me so important, and the consequences of a failure in the first line of Rail-road to be established in this country so fatal to the successful and rapid progress of such works, that I have not hesitated to state my opinion, although not essentially connected with my own immediate investigations. I may also add that this opinion is based upon several years' experience in laying out, and in constructing Rail-roads, and on a practical and not merely general acquaintance with the subject.

I conceive, therefore, that the line now suggested, if found practicable, possesses the following advantages :

1st.—That there would be a saving in the length of the line of one-fifth of the entire distance at present proposed, representing a capital of £1,000,000 sterling, an annual return at 5 per cent of £50,000, and an expenditure of time in its construction of nearly two years.

2nd.—That such a line is infinitely more favourably placed as a trunk line, to be extended to the North-west, than the line now intended to Rajmahal.

3rd.—That the line can be constructed in very nearly the same time as will be required for the construction of the line to Rajmahal, while it will reach a point nearly 200 miles further from the capital, in the heart of the Province.

4th.—That it will render certainly profitable the line now proposed as far as the collieries, while under present arrangements, there is a very doubtful prospect of this branch paying.

5th.—That it must command at least four-fifths of the traffic now calculated on, as to meet the Rail-road at Rajmahal, while at the same time it meets that traffic in a more favourable position.

6th.—That it avoids a dangerous competition with the established and economical communication by the Ganges for a distance of nearly

(a) Should it appear desirable to investigate this point, it is probable that the Officer in charge of the improvements of the present Cart road from Cuthurbaree to Soorajgurrah could supply sufficient information to determine the desirability of trial-sections being made or not.

100 miles, while it offers to the larger portion of the traffic passing along that River, a very much greater rapidity of conveyance to market.

7th.—That throughout nine-tenths of its course it is known to afford most excellent gradients, and for the remaining tenth, it is believed to do so also.

8th.—That throughout its course, there is not a single large River to be crossed, while the line to Rajmahal has to cross the Adji, the More, the Dwarka and the Brahminy.

9th.—That it offers every facility for construction in the proximity of the best materials, stone, brick-clay, wood, &c.

10th.—That it passes along a line of country of rich produce, and where there is at present a very extensive traffic existing, which traffic has been developed without the aid of even a common country road.

11th.—That it would open up a district adjoining to which are known to occur a valuable coal field and metallic mines.

12th.—That it would, from the first, command a large portion of the passenger traffic towards the North-west, while the Rajmahal line cannot be expected to obtain a single passenger, with the exception of the few, who may wish to proceed by the River Steamers from thence.

13th.—That it will at the same time form a ready, rapid and cheap conveyance for the coal of the Damoodah and of the Curhurbaree fields to Patna, and the several depôts on the Ganges; thus at once reducing the cost of fuel at Patna to nearly the same price at which it can now be had at Calcutta.

I believe that these considerations are more than sufficient to justify the preliminary examination of the country. And in conducting such an investigation it might be prudent to bear in mind that heavy traffic trains are daily, nay almost hourly hauled up inclines of 1 in 90 and 1 in 100, at home, without aid from second engines, and without any great loss of power; and carefully to consider whether any slight disadvantage arising from a short incline of steeper gradients, would not be very much more than counter-balanced by the great additional length of line requisite to obtain more favourable inclines, and the consequently greater cost of working afterwards.

I have above estimated the cost of the line as at present proposed to be £10,000 or £11,000 sterling per mile forward, while in the proposed extension of the colliery branch it will be seen that I have calculated £6,000 as the cost per mile. In explanation of this difference, I would remark that in the one case I have supposed the bridges, &c., to be

constructed for a double line of Rails while one line of permanent way should be laid down. In the other case, I have estimated for a single line only, which I have no doubt whatever could be constructed for much less than £6,000 per mile.

I believe the important advantages which single lines offer as compared with double ones, have seldom been fairly considered, or at least, seldom fully estimated, more especially as regards districts where the amount of traffic is small, or even doubtful. Many persons have an idea that nothing but a very limited amount of business can be carried on a single line of Railway, and that even this small traffic is accompanied by great risk of collision. 6215

Now, as perhaps the best way of getting rid of such scruples, is to cite an instance in which the supposed difficulties have been already successfully overcome ; I would simply refer to the great line between Amsterdam and Rotterdam. Seventy-five miles in length, it traverses throughout its entire course, a very highly cultivated and a very populous district, it passes the large cities of LaHague, Leyden, Haarlem, &c., containing a population of upwards of 150,000, independently of its two great termini, which together contain nearly 300,000 inhabitants, and one of which, Amsterdam, is one of the most important commercial cities in Europe. *The whole of the traffic of this line is carried over a single line of Railway.*

In Belgium again with its wealthy and numerous towns, and its large and increasing manufactures, and with a population averaging not less than 378 per square mile, the Rail-road traffic is, with very few exceptions, carried on single lines ; and with equal or even greater security from accidents than has yet distinguished the double lines of England ; while at the same time the public derive the great benefit of proportionally reduced fares.

Surely then, if some of the great manufacturing districts of Europe can fully and most satisfactorily accommodate the entire of their traffic on single lines of Railway, the more agricultural country of India would find such amply sufficient for all the traffic that can, by any possibility, be expected for years to come.

In considering the amount of saving which would result from constructing the works throughout for a single line, instead of a double one, as compared with the whole expenditure for a double line, it is obvious, that no fixed ratio could be stated. This saving will vary with the character of the works to be executed, but will approximately vary in

the inverse ratio of the depths of the cuttings and embankments. But in a country, presenting physical features similar to those of India, at least of that portion of India in which it is proposed to construct Railways, it may be estimated as nearly (2-5ths) two-fifths of the whole ; or as giving a saving of 40 per cent, that is converting a stock paying 3 per cent, into one paying 5 per cent, or *vice versa*.

Again, should the necessity hereafter arise from greatly increased traffic, the widening can clearly be effected with greater advantage to the undertaking. To illustrate this ; suppose the saving in the first cost of the construction of a single line, as compared with a double line to be, say, not more than 25 per cent, (it would be much more in India) ; and that after the lapse of (20) twenty years, the traffic on this line should be so increased as to require a double line of rails : every £1,000 originally saved would during that time, at simple interest at 3 per cent, have amounted to £1,600 ; while on the other hand, if this £1,000 had been at first expended simply to provide for a possible contingency of such increase of traffic, it would, taken at the same rate of interest, have abstracted £600 from the profits of the shareholders.

This question is simply one of economy and profit on the one side ; of needless expenditure and loss on the other. Railways have long ceased to be luxuries ; they have become a matter of hourly necessity to any people, who would not be left behind in the great world of commerce. Cost what they may, they must be extended, until the progress of knowledge may discover some more effective and economical means of transport. It is further a trading and manufacturing population that more essentially requires Railway communication to accommodate that rapid and constant intercourse, so essential to success in commerce ; while to an agricultural people it is necessarily a less pressing want, owing to the absence of any great concentration of population in fixed localities ; and to such a people it can only be rendered partially advantageous by opening out the more important, and more generally accessible points in a district.

It is essential then, that the nation should be able to procure this portion of its daily existence at the smallest possible cost.

But entirely apart from the bearings of the question, viewed in relation to the shareholders, is its important bearing as regards the public, in producing *low fares*. This is so obvious, that it need not be dwelt on here. The value of these low fares may, however, be illustrat-

ed by the fact, that in Belgium the proportion of the population who travel, is stated to be five times greater than in England. And there are few countries where it could be more essential to the success of Rail-roads to be able to carry the public at low fares, than India.

There can be no doubt therefore that the capabilities of a single line are most fully adequate to meet the general Railway traffic of India, and that consequently all expenditure incurred beyond this, is only so much capital abstracted from other useful investments, and acts as a dead weight on the value of the Railway stock.

The vital importance of the extension of facilities for communication in this country, whether considered with reference to the possibility of developing its great industrial resources; of economizing its valuable mineral wealth; of elevating its degraded population; or of enabling an extension of the beneficial influence which invariably and unavoidably springs from the presence of Europeans, and from the free intercourse of persons from different districts; an importance which becomes daily more obvious, and which every hour's experience impresses more forcibly on every thinking mind, will be a sufficient reason for my having entered with some detail, into the facts connected with what appears to me a great improvement in the line of Railway at present contemplated.

And the more so, as I am under the impression that the direction now suggested for a line of Rail-road has not been previously proposed or examined. And at the same time thoroughly convinced that the superior advantages which, if practicable, it would possess, are more than amply sufficient to justify a preliminary examination of the country.

THOMAS OLDHAM,

Supdt. of Geological Survey.

Calcutta, 18th May 1852.

Approximate elevation above the Sea, of places referred to in the preceding Report.

	<i>Feet.</i>
Ahsensole,	306
Belgram,	98
Berhampore,	53
Burrooah,	76
Curbunna, near Bonhaut, ..	130
Damrah,	138
Doblee, ..	49
Dubrajpore, ..	322
Dyoucha,	175
Gobinpore, (from Boiling-point),	503
Gongpara,	48
Gowkurn,	105
Hylapore,*	876
Juggulca,	41
Jumturra,*	617
Kandee, (Jummoo Kandee),	56
Kishnagur,	46
Mowlisher, ..	189
Muddoopore,	935
Muddoobund, (N. of Parasnath Hill),	1236
Neamutpore,	427
Nuggulea,	233
Palgunge,*	744
Palmow,*	833
Parasnath Hill, (Summit), ..	4484
Ditto ditto determined by Boiling-point Thermometer,	4504
Plassey, ..	74
Pursundpore, ..	154
Rajgunge,	746
Ringoo-Chingoo,*	775
Sadipore Baharow,	328
Serampore, ..	920
Synthia, ..	147
Soory,	233
Taldangah,*	401

The above elevations have all been calculated from observations with a Mountain Barometer, taken synchronously with those at the Surveyor General's Office, Calcutta, and to the results thus deduced the elevation of the cistern of the standard Barometer at Calcutta above the Sea, (namely 18·11 feet) has been added. Those which are marked thus (*), being derived from a single observation, are less to be depended on than the others.



